

Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

Staff Report

**Proposed Amendments to
BAAQMD Regulation 8, Rule 20:
GRAPHIC ARTS PRINTING AND
COATING OPERATIONS**



October 2008

Prepared by:

**William Thomas Saltz
Air Quality Specialist
Planning, Rules and Research Division**

STAFF REPORT

Regulation 8, Rule 20: Graphic Arts Printing And Coating Operations

TABLE OF CONTENTS

	<u>Page</u>
I. Executive Summary	1
II. Background	2
A. Introduction	2
B. Graphic Arts Overview	3
C. Inks, Coatings, and Adhesives	7
D. Cleaning Products	7
III. Proposed Rule Amendments	8
A. Exemption: Low VOC-Emitting Facilities	8
B. Ink and Coating Standards	10
C. Cleaning Product Standards	10
D. Other Amendments	12
IV. Emissions and Emission Reductions	13
A. Emissions	13
B. Emission Reductions	14
V. Economic Impacts	15
A. Compliance Costs	15
B. Incremental Cost Effectiveness	17
C. Socioeconomic Impacts	17
VI. Environmental Impacts	18
A. California Environmental Quality Act	18
B. Greenhouse Gas Emissions	18
VII. Regulatory Impacts	19
A. California Health and Safety Code 40727.2 Impacts	19
B. Senate Bill 288 Conformity	19
VIII. Rule Development Process	20
IX. Conclusion	21
X. References	22
Appendices	
1. Responses to Public Comments	
2. Socioeconomic Analysis	
3. CEQA Analysis	

I Executive Summary

The Bay Area Air Quality Management District (District or BAAQMD) staff is proposing amendments to Regulation 8, Rule 20: *Graphic Arts Printing and Coating Operations*, which limits emissions from graphic arts printing operations in the San Francisco Bay Area. The proposed amendments to Regulation 8, Rule 20 will implement Control Measure SS 2 of the 2005 Ozone Strategy. This control measure proposes to reduce volatile organic compound (VOC) emissions by lowering VOC limits for flexographic printing inks, by lowering VOC limits for graphic arts cleaning products, and by lowering the applicability limit in the rule to include more facilities. The majority of the VOC emission reductions will be achieved by tightening the VOC standards for existing graphic arts cleaning products and by adopting VOC standards for other cleaning products. Bay Area graphic arts operations currently emit approximately 5.25 tons per day (TPD) of VOC.

District staff also proposes a number of other amendments. They include the modification of numerous definitions, including that of “graphic arts operations,” and the addition of new definitions in order to clarify the scope and applicability of the rule. In addition, staff has corrected and updated other provisions, including modifications to Recordkeeping Requirements (Section 8-20-503) and Method of Determining VOC Emissions from graphic arts operations abated by an emission control system (Section 8-20-602) to verify compliance and enhance the enforceability of the rule. A new labeling requirement in Section 8-20-306 will assist both graphic arts operators and enforcement staff to determine compliance with VOC and permitting requirements. Staff also recommends deleting the Alternate Emission Control Plan (Section 8-20-304) and the Extreme Performance Screen Printing Petition for low-VOC emitters (Section 8-20-407).

Regulation 8, Rule 20 is an industry specific rule that applies to graphic arts operations that apply inks, coatings, and adhesives to substrates to create images. Currently, these operations include:

- Lithographic Printers
- Flexographic Printers
- Gravure Printers
- Screen Printers
- Letterpress Printers

The District is in non-attainment for both the state 1-hr and 8-hr ozone standards. The District is a marginal non-attainment area for the previous (0.08 ppm) national 8-hr ozone standard and has not yet been designated for the recently revised national standard. State law requires that the District implement all feasible measures to reduce emissions from ozone precursors, including VOC.

Currently, Regulation 8, Rule 20 does not apply to the digital printing industry. Under the proposed amendments, digital printers will continue to be exempt from Regulation 8, Rule 20, with the exception of record keeping requirements to track VOC emissions from commercial digital printing. These records will help the District develop an accurate emissions inventory and evaluate a potential future digital printing regulation.

The proposed amendments for Regulation 8, Rule 20 will reduce VOC emissions by at least 1.65 TPD – a 31% reduction from this source category. The proposed amendments are considered to be cost-effective and a socio-economic analysis has determined that these amendments can be implemented without significant economic dislocation or loss of jobs. A California Environmental Quality Act (CEQA) Initial Study has determined that there are no significant adverse environmental impacts associated with this project.

In conjunction with the proposed amendments to Regulation 8 Rule 20, amendments to *Regulation 2: Permits, Rule 1: General Requirements* will require only those facilities that emit 400 lbs VOC or more per month to obtain a permit to operate. Low emitting graphic arts operations may register with the District in lieu of obtaining a permit. The initial registration fee will be \$215.00 and an annual renewal fee will be \$135.00, as reflected in the proposed amendments to *Regulation 3: Fees, Schedule R: Equipment Registration Fees*.

II Background

Introduction

The District adopted Regulation 8, Rule 20 on April 12, 1980 and amended it five times thereafter. The rule has significantly reduced VOC emissions from Bay Area graphic arts operations by establishing VOC emission limits for inks, cleaning products, and other graphic arts products and by requiring the use of add-on control (abatement) devices for graphic arts operations using materials that exceed specified VOC limits.

The District adopted the last amendments in 1999. The District added VOC limits for cleaning materials used in graphic arts operations and lowered the threshold of VOC emissions that triggers subjecting a graphic arts operation to regulation under this rule.

The Bay Area 2005 Ozone Strategy's Stationary Source Measure SS 2 proposed that the District examine potential further emission reductions, based in part on the regulatory activities of other air districts. For example, the South Coast Air Quality Management District (SCAQMD) solvent cleaning rule, Rule 1171, and the San Joaquin Valley Unified Air Pollution Control District graphic arts printing rule, Rule 4607, have more stringent VOC limits for graphic arts cleaning solvents than does the District currently. Also, there are air districts that regulate graphic arts operations at a lower VOC-emissions threshold than the District's current exemption for 175 lbs of VOC emissions per month.

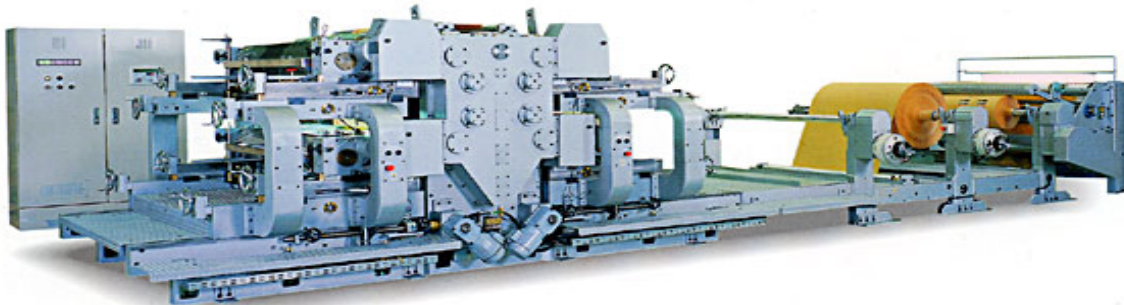
There are 261 permitted graphics arts facilities in the Bay Area. There are many additional facilities that do not have District permits. Printing establishments range in size from single-person print shops to large newspaper, packaging, and flexible packaging operations. Most graphic arts operations are low-emitting facilities, many of which are currently exempt from the requirements of Regulation 8, Rule 20 because they emit less than 175 lbs VOC per month. Some facilities use a single printing technology; others use a combination of printing technologies, including lithographic, flexographic, screen printing, and gravure.

Graphic Arts Overview

Graphic arts facilities use printing presses to produce “images” on substrates. A substrate is the base material onto which images are printed. Each press is comprised of one or more printing units that print one color at a time. Substrates onto which images are printed are either continuous (web) or in pieces (sheets). The Bay Area’s graphic arts industry can be divided into six different printing technologies, five of which are currently subject to Regulation 8, Rule 20.

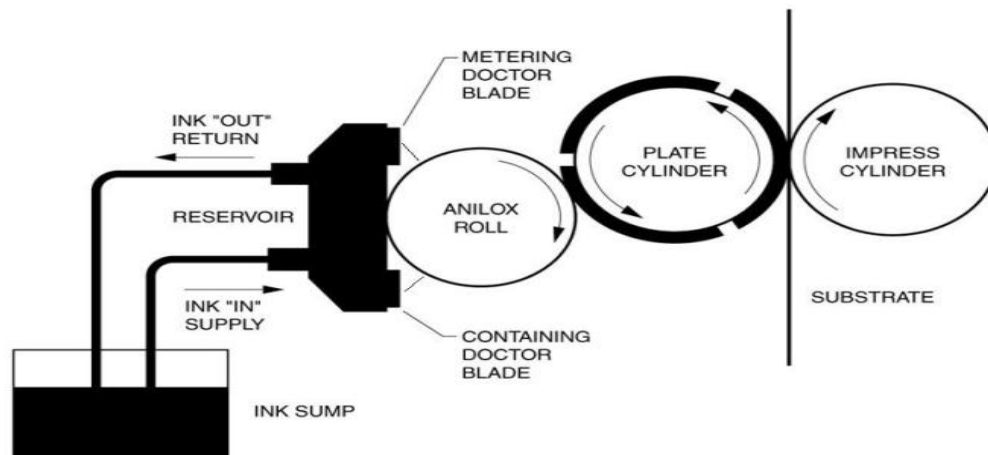
1. Letterpress – The oldest method of printing in which a raised inked surface prints directly onto the substrate. Letterpress printing was a common technique for periodicals and newspapers, but it is being replaced by other types of printing, such as lithography and digital printing.
2. Flexographic – A printing method in which the image carrier is made of rubber or other elastomeric material and the image is raised above the non-image areas. Typical substrates include textiles, paper, paperboard, plastic, acetate film, and foil. Figure 1 is a picture of a large flexographic press. Figure 2 is a schematic diagram of a flexographic press.

Figure 1
Large Flexographic Press



Source: PIA Northern California

Figure 2
Schematic of a Flexographic Press



Source: PIA Northern California

3. Gravure – A printing method in which the ink is transferred from minute etched wells in a plate to the substrate, which is supported by an impression roller. When a rotating drum or cylinder is used to transfer an image to the substrate, this process is called rotogravure printing.
4. Lithographic – A printing method in which the image and non-image areas are on the same plane. (Lithographic printing is also known as planographic printing.) Lithography is a technique in which the inked image is transferred (or "offset") from a plate to a rubber blanket, then to the printing surface. The lithographic process is based on the principle that water and oil do not mix. The non-image area is receptive to water, and the image area is receptive to ink and repellent to water.

There are two types of lithographic printing: sheet-fed and web. Sheet-fed presses run individual sheets of paper through the press, while web presses feed paper continuously from a large roll and can use either heatset or non-heatset inks. Once the image is printed onto the substrate, the paper is either fed back onto a roll or cut and/or trimmed into specific shapes and sizes. Web lithography is designed to print large jobs; it prints newspapers, books, catalogs, periodicals, advertising and business forms. Sheet-fed lithography is used mostly for short runs of books, periodicals, posters, advertising flyers, brochures, greeting cards, packaging and fine art reproduction.

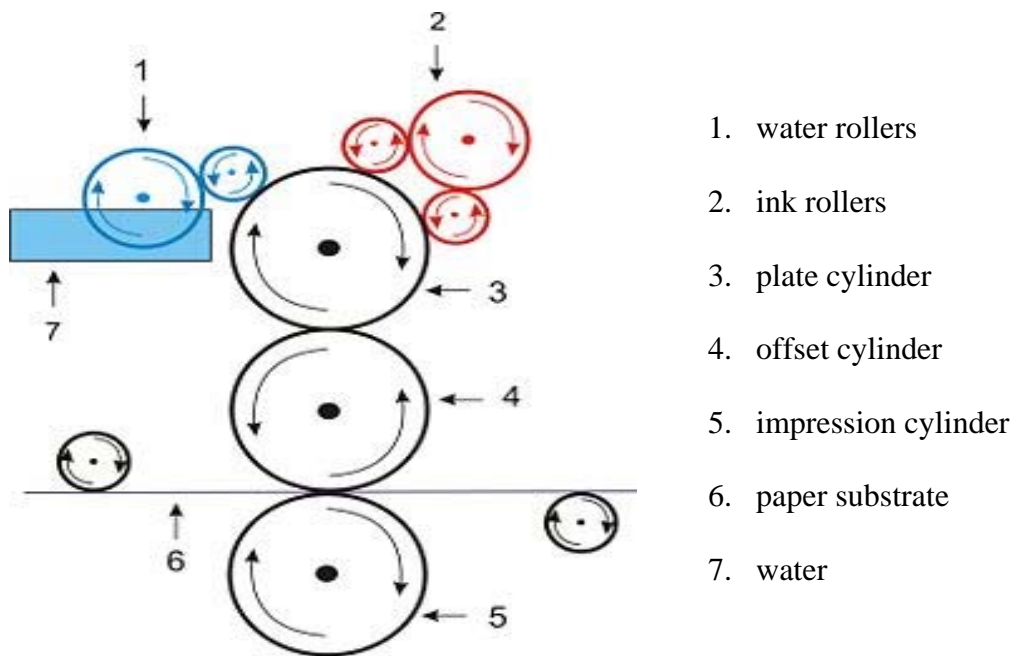
Lithographic printing operations account for over 50 percent of the permitted graphic arts operations in the Bay Area. Figure 3 is a picture of a small, sheet-fed lithographic press. Figure 4 is a schematic diagram of a lithographic transfer process.

Figure 3
Small Lithographic Press



Source: Heidelberg

Figure 4
Schematic of Lithographic Press



Source: Wikipedia

5. Screen Printing – A method of printing, also known as silk screening, which utilizes a stenciling technique. The ink is forced through the open areas of a stencil and deposited onto a substrate.
6. Digital Printing – A non-traditional, non-impact printing method that is not currently subject to the requirements of Regulation 8, Rule 20. Digital printing includes inkjet, electrophotographic, thermal transfer, and dye sublimation technologies. There are several differences between digital printing and traditional printing. First, most digital printing processes do not use a permanent or semi-permanent physical plate to create images. Rather, computer-generated electronic signals are sent to the printing press to create a temporary plate that may last for only one impression. Consequently, the digitally-created image plates are not static. The electronic signal can create images that can vary from one impression to the next. Digital printing requires considerably less time to set up a print job than the traditional printing methods. Traditional printing plates can only produce a single image for the length of the press run whereas digital printing can change an image with each impression. Second, digital printing can be used on a variety of substrates, and, unlike most traditional printing, is not limited to flat substrates, such as paper, cardboard, and other packaging materials. Digital printing is an evolving technology, which air districts are only now beginning to examine. Some digital printing methods utilize inks and solvents that contain significant amounts of VOC and that may produce significant VOC emissions.

Graphic arts operations can be further classified by the type of substrates that are printed on by the specific printing technologies. The graphic arts industry prints images onto a wide array of substrates. Substrates include foil, paper, cardboard, film, plastic, metal, and vinyl, and three-dimensional surfaces. Due to market demand, the types of printing substrates continue to increase. Consequently, graphics arts operations use an increasing variety of coatings, inks, and adhesives to keep up with the demand. Table 1 lists products that are typically printed on by specific printing technologies.

Table 1 -- Products Printed By Each Graphic Arts Technology	
Printing Technology	Examples of Products
Letterpress	announcements, business cards, letterhead, proofs, form documents, posters, embossing and hot-leaf stamping
Flexographic	flexible packaging materials, cups, cartons, bags, pressure sensitive labels, film, plastic, and foil
Gravure	books, greeting cards, and packaging materials
Lithographic	newspapers, books, business forms, financial and legal documents
Screen	clothing, textiles, flyers, billboard advertisements, and skate boards
Digital	documents, packaging material, medical devices, billboards, plastic, car seat foam, clothing, vinyl signs, rubber tubing, and metal

Inks, Coatings, and Adhesives

Graphic arts operations use inks, coatings, and adhesive materials during printing processes. Some of these materials contain VOC.

Each graphic arts technology requires the use of inks that are specific to the printing process and the substrates. Therefore, the composition of inks varies significantly from one process to another. Inks are petroleum-based, water-based, or agriculturally-based materials (such as vegetable oils). As a result, the physical properties of inks vary, such as their viscosity, tackiness, and drying time. Further, each printing technology usually requires the application of a precise thickness of ink to a substrate to produce an optimum image.

Graphic arts inks also dry by various methods. Traditional inks, such as newspaper printing inks and sheetfed printing inks, dry by one of three methods: absorption into the substrate, evaporation, or oxidative polymerization. In the oxidative polymerization process, ink additives react with oils to speed up polymerization, thus turning wet inks into a solid. It is a process that improves the glossiness of an ink and can make the surface scratch and rub-resistant.

Lithographic, flexographic, gravure, and screen printing operations can use ultraviolet (UV) inks, coatings, and adhesives that are based on radiation curing technology. It is a technology that utilizes short wavelength UV, or high energy electrons from electron beam (EB) sources, to cure (cross-link) special reactive inks, coatings, and adhesive formulations. The benefits of UV and EB graphic arts products include: (1) very quick curing, which allows for higher press speeds, (2) improved adhesion to substrates; and (3) an ability to render final products with physical and chemical resistant properties. Ultraviolet and electron beam inks emit almost no VOC. However, many of the cleaners used to clean press equipment that apply UV and EB graphic arts products are solvent-based and contain VOC.

Graphic arts operations utilize coatings in a variety of ways. Coatings include varnishes, aqueous-based and solvent-based coatings, UV coatings, and laminates. Coatings can provide a background color onto which inks may be applied. Coatings also protect the surface of the final product from damage due to abrasion, water, or chemicals. One example of a chemical-resistant coating is the anti-corrosion coating applied to orange juice cartons to protect them against deterioration caused by the acid in the juice. Applications also include textiles, such as those used for hot and cold air inflatable advertising media, displays, and banners.

Graphic arts operations use adhesives in both the printing and production processes. Operators print on pressure-sensitive adhesive products, such as labels, decals, and tapes. Graphic arts operations use adhesives in production processes, including to bind books and magazines; to temporarily secure textile substrates during screen printing operations; and to manufacture flexible packaging products, such as boxes, cans, and wraps.

Cleaning Products

The graphics arts industry uses a variety of cleaning products to remove excess printing inks, oils, grease, coatings, and adhesives and to remove unwanted dust, debris and other

pressroom contaminants.

Most Bay Area graphic arts operators use VOC-containing cleaning products to clean external parts of the printing press manually and to clean internal areas of the press manually and mechanically. Press operators apply small amounts of cleaning solvent to a cloth and then hand wipe blankets, rollers, cylinders, drums, and ink tools, ink trays, ink cans, ink rails, pipe rollers, and spray bars. Used cloths are disposed of as hazardous waste. Automated systems clean internal parts of the press, such as those that apply blanket washes on lithographic presses. One of the advantages of an automated press cleaning feature is the ability of a press operator to clean a press while simultaneously printing jobs.

Another source of VOC emissions relates to the cleaning of press parts that are not directly involved in the creation or application of images or that do not typically come into contact with printing inks (“other press parts”). Other press parts are cleaned with products containing solvents. Other press parts include, but are not limited to, non-image areas of printing plates, catwalks, motors, belts, die cutters, side frames, gripper bars, delivery units, ink pumps, dryer boxes, drip pans, and ink trays.

Cleaning products are available in a range of quantities, ranging from 1-gallon to 50-gallon drums. Distributors state that cleaning products that are purchased in large containers are transferred into smaller containers, such as squirt bottles, to clean printing presses.

III Proposed Rule Amendments

The District proposes amendments to Regulation 8, Rule 20 that will reduce VOC emissions from the Bay Area’s printing industry in three ways: (1) lowering the exemption limit; (2) lowering the VOC limit for flexographic ink used on porous substrates; and (3) lowering the VOC limits for graphic arts cleaning products in three stages. The majority of the VOC emission reductions will be achieved by tightening the VOC standards for existing graphic arts cleaning products and by adopting VOC standards for other cleaning products.

Exemption: Low VOC-Emitting Facilities

Most California air districts provide an exemption from their graphic arts regulations for low-emitting graphic arts operations. There are 261 permitted graphic arts facilities within the District. Eighty-five of the 261 facilities emit less than 175 lbs of VOC per month and thus currently are exempt from the standards of Regulation 8, Rule 20. As a review of all feasible measures associated with the printing industry, staff considered lowering the threshold of graphic arts operations that are subject to Regulation 8, Rule 20 and eliminating the low-emitting operations exemption altogether. After reviewing the Bay Area’s graphic arts emissions inventory, staff determined that eliminating the low emissions exemption is not warranted because considerable District resources (engineering, inspection, and technical staff) would be required to address a minimal emission reduction. However, staff determined there would be a benefit to lowering the threshold.

Staff analyzed the emissions from those permitted graphic arts facilities that are currently exempt from Regulation 8, Rule 20. Staff identified a cluster of facilities emitting substantially more than 75 pounds per month of VOC and a second cluster of facilities emitting at least 10 pounds less than 75 pounds per month. Based on that break point at 75 pounds per month, staff proposes lowering the exemption threshold from 175 pounds VOC per month to 75 pounds VOC per month. The lower threshold will result in 77% of currently-exempt graphic arts facilities becoming subject to the standards of Reg. 8-20. Facilities that emit less than 75 lbs of VOC per month will be exempt from the rule except for specific recordkeeping requirements. Lowering the exemption limit would impact at least 48 known facilities but may impact up to 25 additional facilities that are currently not in the District's database.

The current low-emitting facilities exemption in Regulation 8, Rule 20 is based on the quantity of VOC emissions per month from graphic arts operations. Currently, some of these exempt facilities require a permit to operate because they either emit 150 lbs of VOC per year, or use 30 gallons of ink or coating per year, or use 20 gallons of solvent per year (see District Regulation 2, Rule 1). Proposed amendments to Regulation 2, Rule 1 will require only those facilities that emit 400 lbs VOC or more per month to obtain a permit to operate. Facilities that emit less than 400 lbs VOC per month but at least 75 lbs VOC per month (the level at which Regulation 8, Rule 20 standards will become effective) will be required to register with the District in lieu of obtaining a permit.

There are several reasons for this proposal. First, if a graphic arts operation is subject to the rule, they will be required to either register or obtain a permit, depending on the level of emissions. This correlation will help clarify the applicability of District requirements to the printing industry. Second, due to the administrative costs of obtaining a permit, permit fees do not fully recover the cost of permitting and enforcement for many low-emitting facilities. In addition, a low-emitting facility in this industry can incur substantial permitting costs, particularly under "Waters Bill" notification requirements for use of any amount of a toxic air contaminant or a hazardous air pollutant within 1,000 feet of a school.¹ Registration, a much simpler process, will recover estimated costs for administration and enforcement activities for affected facilities.

In addition to reducing emissions by requiring some low VOC-emitting facilities to comply with the standards in Reg. 8-20, registration will cost the smaller facilities less than the cost of obtaining a permit to operate, and in many cases result in a savings. Staff is proposing an initial registration fee of \$215.00 and an annual renewal fee of \$135.00. By contrast, currently, a low-emitting facility subject to permitting requirements will pay approximately \$500.00 for the initial permit to operate and related fees and will pay approximately \$260.00 each year thereafter for the permit renewal and related fees, depending on the number of sources. If a facility is subject to the Waters Bill, there may be a requirement to submit a public notice for schools that will cost between \$2,000.00 and \$3,000.00. The registration fees are included in a proposed amendment to Regulation 3: Fees, Schedule R: Equipment Registration Fees.

Some low VOC-emitting facilities that currently require permits to operate would become exempt from the permit requirement, although they would be required to register

¹ California Health and Safety Code 42301.6(b) and BAAQMD Regulation 3, Section 318.

as described above. These facilities have the option of retaining their permits or switching to the registration system. The District is currently developing a web-based registration system to simplify the registration procedure.

Ink and Coating Standards

Currently, Regulation 8, Rule 20 contains a VOC limit of 300 grams/liter (g/l) for all flexographic ink. District staff proposes to divide flexographic printing into porous and non-porous categories by proposing a VOC limit of 225 g/l for flexographic inks applied to porous substrates while retaining the existing 300 g/l limit for non-porous substrates.

The purpose of this amendment is to align the rule with current printing industry practices and regulatory standards elsewhere in California. Flexographic inks containing less than 225 grams of VOC per liter have been used on porous substrates for several years. The District anticipates achieving a modest VOC emission reduction as a result of this amendment because our emissions data indicates that emissions from flexographic ink applied to porous substrates account for less than 5% of VOC emissions from all Bay Area graphic arts operations.

Cleaning Product Standards

Currently, the cleaning products used in flexographic printing, specialty flexographic printing, and ultraviolet printing operations must comply with both a VOC standard of 800 to 880 g/l and composite partial pressure (CPP) limit of 21 mm to 33 mm Hg, whereas cleaning products used in lithographic printing, screen printing, and gravure printing operations must comply with either the applicable VOC limit or a CPP limit of 10 to 25 mm Hg. Cleaning products in this latter category that meet the CPP limit typically have a significantly higher VOC content than the 300 g/l option. Although lower CPP products evaporate more slowly, the use of low-VOC cleaning products are a much better way of reducing VOC emissions. Staff proposes the deletion of the CPP limits when proposed lower VOC standards become effective.

District staff proposes adopting VOC standards for cleaning products that have a lower VOC content but are effective in cleaning graphic arts equipment. Cleaning products with lower VOC contents, in the range of 450 g/l to 650 g/l, have been used successfully in other air districts. Staff recommends reducing the VOC limits in two phases – lowering the limit initially in 2009 and then again in 2010 or 2011 as described in more detail below. This approach will provide cleaning product manufacturers sufficient time to further refine low-VOC formulations and to ramp up production. An additional benefit of the phase-in period is that the printing industry will have time to adapt to using the new products. The final VOC limits will be the same as those required by the South Coast and the San Joaquin districts, and are being considered in other districts.

The implementation date for 100 g/l cleaning products for specialty and screen printing graphic arts operations will be delayed until July 2011 to allow further reformulation research and development. Industry representatives and two Bay Area specialty graphic arts operators that print on packaging substrates inform staff that low VOC cleaning products, less than 500 g/l, for specialty and screen printing graphic arts operations are not effective at this time. However, a 100 g/l VOC standard has been adopted in other California rules, so staff anticipates that low-VOC cleaning products will become

available for these operations. Staff estimates that the July 2011 date will allow sufficient time to develop and evaluate products for these operations, given the increasing need for such products. Staff will work with industry to ensure that effective products will be available by the proposed July 1, 2011 compliance date.

Proposed amendments also include VOC limits for cleaning products not currently subject to Regulation 8, Rule 20. This will further reduce VOC emissions from the graphic arts industry. VOC standards would be set on products that clean adhesive application equipment, letterpress printing parts and other press parts (maintenance and repairs for non imaging equipment). Table 2 summarizes the proposed VOC standards for cleaning products and corresponding compliance dates.

Table 2 -- Proposed VOC Limits for Cleaning Products

Equipment	Effective 7/1/09	Effective 7/1/10	Effective 7/1/11
Graphic Arts Operation	<u>VOC content g/l (lb/gal)</u>	<u>VOC content g/l (lb/gal)</u>	<u>VOC g/l (lb/gal)</u>
<u>For Press Equipment, except Other Press Parts</u>			
<u>Flexographic Press</u>	<u>500 (4.2)</u>	<u>25 (0.21)</u>	
<u>Specialty Flexographic or Lithographic Press*</u>	<u>500 (4.2)</u>		<u>100 (0.83)</u>
<u>Gravure Printing Press (Packaging)</u>	<u>450 (3.7)</u>	<u>25 (0.21)</u>	
<u>Gravure Printing Press (Publication)</u>	<u>450 (3.7)</u>	<u>100 (0.83)</u>	
<u>Letterpress Press</u>	<u>500 (4.2)</u>	<u>100 (0.83)</u>	
<u>Lithographic Press, by Manual Washing</u>	<u>500 (4.2)</u>	<u>100 (0.83)</u>	
<u>Lithographic Press, by Automated Washing</u>	<u>650 (5.0)</u>	<u>100 (0.83)</u>	
<u>Screen Printing Press</u>	<u>500 (4.2)</u>		<u>100 (0.83)</u>
<u>Adhesive Application Equipment</u>	<u>500 (4.2)</u>	<u>25 (0.21)</u>	
<u>Ultraviolet Ink Removal, Any Press Type</u>	<u>650 (5.0)</u>	<u>100 (0.83)</u>	
<u>Other Press Parts</u>	<u>450 (3.7)</u>	<u>25 (0.21)</u>	

*A new category -- Specialty Lithographic -- has been added to the category of specialty cleaning products. Lithotype Press is a one-of-a-kind operation in the Bay Area that uses an offset lithographic process to print on packaging materials. Lithotype's offset printing operation requires the same VOC cleaning product limits as flexographic packaging printers.

Other Amendments

Exemptions: Staff has proposed several new exemptions to the Rule: digital printing equipment, cleaning products used on ultraviolet lamps and reflectors, stripping of cured ultraviolet and electronic beam products, printing operations subject to other rules, and hand-screened wallpaper. The exemptions for digital printing, lamps and reflectors, and equipment subject to other rules merely clarify the applicability of the Rule where questions have arisen in the past. One operator in the District screen prints wallpaper by hand and has relied on the current low-emitting facilities exemption to use the materials needed for such operation. It is a labor intensive and nearly unique operation in the nation. There are no alternative inks for this type of operation on porous (paper) wallpaper and given the small size of this industry, staff do not anticipate there being a significant demand to lower VOC contents of necessary materials. The exemption would allow the source to operate at its current capacity but not let them increase emissions.

Regulation 2, Rule 1: Permits and Regulation 3: Fees: As discussed above, under Exemption: Low-Emitting Facilities, proposed changes to Regulation 2, Rule 1: Permits, would change the requirement for a permit from the current 30 gallons of ink, coating and adhesive or 150 lbs emissions from ink, coating and adhesive, to 400 lbs VOC emissions per month, which includes emissions from clean-up solvent and fountain solutions. Concurrent with the proposed requirement to register these low-emitting facilities, proposed amendments to Regulation 3: Fees, Schedule R: Equipment Registration Fees would assess a \$215 fee for an initial registration and an annual renewal fee of \$135.

Alternative Emission Control Plan: Staff has proposed deletion of the provision allowing press operators to use an alternate emissions control plan (AECp). The AECp was intended to allow large press operators to exceed VOC limits for some inks if the total emissions were less than the use of all complying inks. In practice, sources have either been abated if they are sufficiently large presses where the potential benefit of an AECp was not enough to ensure reductions to a complying level, or complying products have been found so that the lengthy emissions calculations required to show daily compliance have not been necessary. No sources have used the AECp provisions since 2000, so staff proposes deleting it.

VOC Labeling: A proposed amendment to Section 8-20-306 will require manufacturers to provide VOC information on the labels of graphic arts products, and prohibit distribution of non-labeled products. Doing so will help to ensure that press operators use compliant products. Some graphic arts cleaning products are sold in concentrated forms and are to be diluted before they are used on press equipment. As of July 1, 2009, VOC information on labels would require manufacturer recommended dilution ratios to ensure that the VOC limits for cleaning products are met as they are applied, not as they are stored in a container.

Digital Printing: Commercial Digital Printing (DP) is a relatively new graphic arts technology that is not currently regulated by any California air districts. Some digital printing operations create images by using dry toners, inks, and waxes that contain virtually no VOC. However, other DP operations, including inkjet printing and some newer technologies, use high-VOC content inks. The extent of VOC emissions from digital printing sources is not yet well known. Staff proposes an amendment to Regulation 8, Rule 20 to track VOC emissions from commercial digital printing

operations to determine the feasibility of developing a future rule specific to that industry.

Administrative requirements: A requirement has been added to label squirt bottles with the type of cleaning product they contain. This will allow District inspectors to ascertain the VOC standard that applies to the cleaning product and more easily enforce the Rule. As previously discussed, a registration requirement has been added in the Administrative Section of the rule for low-emitting facilities. Also, calculations have been added to clarify emissions calculations to determine exemptions.

In addition, based on input from affected industry and District enforcement, engineering and technical staff, numerous changes are proposed to the definitions, recordkeeping, and Manual of Procedures sections of the rule. These changes are intended to clarify the intent of the rule, and add VOC content calculations.

IV Emissions and Emission Reductions

A. Emissions

The total VOC emissions from permitted Bay Area graphic arts operations are 5.25 tons per day (TPD). The District's graphic arts emission inventory is derived from the sum of VOC emissions reported on annual update forms submitted by all permitted graphic arts facilities to the District prior to renewing their permits to operate. Update forms contain the throughput of various printing-related materials used by facilities during the previous twelve months. The sources of VOC emissions include inks, coatings, and certain cleaning solvents from letterpress, lithographic, gravure, screen and flexographic printing operations. Emissions from a relatively small number of permitted digital printing operations that use solvent cleaning products, such as inkjet and bubble jet printers, are also included in the emissions inventory.

The emissions inventory does not include VOC emissions from the following sources:

- Adhesive materials or from cleaning products used to clean adhesive application materials,
- Products used to clean press equipment that apply UV inks, coatings, and adhesives; and,
- Solvents and liquid inks used in most commercial digital printing operations in the Bay Area.

Based on the District's emissions inventory, and comparable information from other Districts, approximately 75 – 80% of the emissions come from lithographic presses. The remainder is split between flexography (about 10%) and screen printing (about 10%). Letterpress and gravure printing collectively make up less than 5% of the emissions inventory.

Digital printing operations are not regulated by Regulation 8, Rule 20. However, they currently require a permit to operate if they use more than 30 gallons of inks and coatings per year pursuant to Regulation 2, Rule 1. Based on emissions from permitted inkjet and electrophotographic printing operations in the Bay Area, staff estimates the emissions from digital printing operations to be between 0.07 TPD and 0.15 TPD. Accordingly, the estimated total of VOC emissions from graphic arts operations and printing operations in

the Bay Area, including digital, is between 5.32 TPD and 5.4 TPD.

B. Emission Reductions

The calculations for estimated VOC emission reductions are based on the emissions inventories and reports from permitted Bay Area graphic arts operations. District staff calculated the estimated emission reductions based on the anticipated reduction of VOC emissions from the current VOC limits multiplied by the quantities of each type of product used. The estimated quantities and emissions reductions are based on industry data and District permit information. District staff also estimated the emissions reductions from the proposed amendment to lower the applicability limit of the Rule from 175 lbs VOC per month to 75 lbs VOC per month.

Table 3 summarizes the emission reductions the proposed rule amendments will yield for flexographic ink and cleaning products during calendar year 2009 and 2010 (2011 for specialty flexographic and lithographic cleaning products and screen cleaning products). The total emission reductions from the proposed amendments as shown in Table 3 are estimated to be 1.65 TPD.

Table 3 -- Estimated VOC Emission Reductions			
Printing Technology	2009 Emission Reductions (TPD)	2010 (2011*) Emission Reductions (TPD)	Total Emissions Reduction
Flexographic Porous Ink	0.1	--	0.1
Adhesive Cleaning Products	0.022	0.034	0.056
Flexographic Cleaning Products	0.013	0.0182	0.0312
Gravure Cleaning Products	0.0009	0.0001	0.0010
Letterpress Cleaning Products	0.013	0.018	0.031
Lithographic Hand Cleaning Products	0.26	0.52	0.78
Lithographic Automated Cleaning Products	0.113	0.41	0.523
Ultraviolet Ink Cleaning Products	0.0005	0.008	0.0085
Specialty Flexographic and Lithographic Cleaning Products	0.007	0.0098*	0.017
Screen Printing Cleaning Products	0.029	0.05*	0.08
New Exemption Limit	0.023	--	0.023
Emission Reductions	0.58 TPD	1.07 TPD	1.65 TPD

* The second phase of emissions reductions from Specialty Flexographic and Lithographic Cleaning Products and Screen Printing Cleaning Products achieved in 2011.

V Economic Impacts

A. Compliance Costs

Flexographic Ink

On average, the cost for each pound of the most commonly used flexographic ink that is applied to a porous substrate is between \$1.00 -- \$5.00. The price can be higher for custom-formulated specialty ink. Ink that has been reformulated from 300 g/l of VOC content to 225 g/l should cost, on average, 3.5% more than 300 g/l ink, according to ink manufacturers. The price range differential is shown Table 4.

Table 4

Compliance Cost for Flexographic Ink Applied to Porous Substrates			
Flexographic Ink	Cost at current VOC Limit 300 g/l	Cost when VOC Limit is 225 g/l	Cost Effectiveness
Flexographic Ink for Porous Substrate	\$1.00 - \$5.00 per pound	\$1.035 - \$5.18 per pound	\$112 - \$576 per ton VOC reduced

Cleaning Products

Staff developed costs for cleaning products currently in use from discussions with manufacturers, vendors and users of these products. The cost of most graphic arts cleaning products used in the Bay Area range from \$10.00 - \$20.00 per gallon. Cleaning products used to clean specialty inks and some adhesives may cost a little more. In 1999, the South Coast AQMD developed lower VOC standards for printing presses and projected costs assuming that the lower VOC products would be formulated by replacing conventional solvents with exempt solvents (solvents that EPA has determined to be negligibly reactive), including acetone, parachlorobenzotrifluoride (PCBTF), and methyl acetate. In technology updates in 2003 and 2006, however, the South Coast found that the majority of low-VOC products developed were water based, or made from methyl ester-based products that have a very low VOC content. Acetone based products are available for some applications, but are not used for rubber-based printing plates or rollers due to the corrosive or warping effects on rubber. PCBTF has not been widely used due to the cost of the solvent.

District staff based its compliance costs on information provided by the San Joaquin and South Cost air districts and the District's own telephone survey and research. The San Joaquin district evaluated the prices of lower VOC cleaning products, concurrent with BAAQMD efforts, and projects no price increase. On the other hand, a 2006 report to the South Coast AQMD by the Printing Industries of California and Graphic Arts Technical Foundation found price increases up to 300% for some cleaners that were tested for efficacy, but found other concentrated water-based cleaning products that, when diluted for use, were 65% to 88% cheaper. District staff then conducted a telephone survey to determine the price of cleaning products. Staff surveyed 11 suppliers and press operators, and found that the projected price increases averaged 3.5%. In many cases, the cleaning products are the same products as are currently used mixed with exempt solvent or water. Moreover, staff found that, as the costs of petroleum based cleaners have increased, the cost of methyl ester-based cleaners (derived from soy) and the cost of

water based cleaners have increased at a lesser rate. The compliance costs for various graphic arts cleaning products are shown in Table 5. In this evaluation, staff assumed that the 3.5% cost increase reported by vendors applies to each of the proposed VOC limit reduction phases, in 2009 and in 2010 or 2011 (where applicable).

Table 5

Current and Projected Costs for Cleaning Products			
Graphic Arts Cleaning Product	Cost at Current VOC Limits	Estimated Cost Increase	Cost Effectiveness *
Lithographic Printing Hand Press Wash	\$10 - \$12 per gallon	7%	\$245 - \$295 per ton
Lithographic Printing Automated Press Wash	\$11 - \$13 per gallon	7%	\$285 - \$335 per ton
Rotogravure Publication Cleaning Product	\$9.75 - \$10.75 per gallon	No change	\$0
Rotogravure Packaging Cleaning Product	\$10.20 - \$10.90 per gallon	No change	\$0
Flexographic Press Cleaning Product	\$11 - \$13 per gallon	No change	\$0
Letterpress Cleaning Product	\$10.50 - \$11.50 per gallon	7%	\$295 - \$325 per ton
Adhesive Application Cleaning Product	\$20.25 - \$21.75 per gallon	- 25% (decrease)	Cost savings
UV and EB Cleaning Products	\$13.65 - \$13.95 per gallon	No change	\$0
Other Press Parts Cleaning Products	\$9.55 - \$10.25 per gallon	No change	\$0
Specialty Flexo and Litho Press Wash	\$13.75 - \$16.25 per gallon	No change	\$0
Screen Printing Press Wash	\$18.10 - \$18.90 per gallon	- 16% (decrease)	Cost savings

* The range given includes cost effectiveness for both the interim (July 2009) and final (July 2010 and July 2011) VOC standards.

In addition, in proposed amendments to Regulation 3, Schedule R: Equipment Registration fees, there are costs for registration of printing equipment from facilities that emit at least 75 lbs VOC emissions per month but less than 400 lbs VOC emissions per month. The amendments propose an initial cost of \$215.00 for a low-emitting facility to register. The cost to re-register annually is \$135.00. This is less than the current cost to permit comparable equipment. It is expected that costs for low-emitting facilities that are currently permitted will be reduced.

B. Incremental Cost Effectiveness

Section 40920.6 of the California Health and Safety Code requires air districts to perform an incremental cost analysis for any proposed Best Available Retrofit Control Technology rule or feasible measure. Air districts must: (1) identify one or more control options achieving the emission reduction objectives for the proposed rule; (2) determine the cost effectiveness for each option; and (3) calculate the incremental cost effectiveness for each option. To determine incremental costs, the air district must “calculate the difference in dollar costs divided by the difference in the emission reduction potentials between each progressively more stringent potential control option.”

No discernable increments have been determined for lower VOC limits for flexographic ink applied to porous substrates. For the purposes of the analysis, staff used the interim and final limits for graphic arts cleaning products and calculated the cost effectiveness for each by dividing the incremental product cost by the incremental tons of VOC reduced. The incremental cost effectiveness for the proposed VOC amendments is shown in Table 6.

Table 6

Incremental Cost Effectiveness (CE) for Cleaning Products, Interim and Final Limits			
Graphic Arts Cleaning Product	Current Product Costs	Interim Limit CE - 2009	Final Limit CE - 2010*
Lithographic Printing Hand Press Wash	\$10 - \$12 per gallon	\$20 - \$560 per ton	\$170 - \$180 per ton
Lithographic Printing Automated Press Wash	\$11 - \$13 per gallon	\$910 - \$1100 per ton	\$170 - \$195 per ton
Rotogravure Publication Cleaning Product	\$9.75 - \$10.75 per gallon	\$0	\$0
Rotogravure Packaging Cleaning Product	\$10.20 - \$10.90 per gallon	\$0	\$0
Flexographic Press Cleaning Product	\$11 - \$13 per gallon	\$0	\$0
Letterpress Cleaning Product	\$10.50 - \$11.50 per gallon	\$445 - \$505 per ton	\$220 - \$435 per ton
Adhesive Application Cleaning Product	\$20.25 - \$21.75 per gallon	Cost savings	Cost savings
UV and EB Cleaning Products	\$13.65 - \$13.95 per gallon	\$0	\$0
Other Press Parts Cleaning Products	\$9.55 - \$10.25 per gallon	\$0	\$0
Specialty Flexo and Litho Press Wash*	\$13.75 - \$16.25 per gallon	\$0	\$0
Screen Printing Press Wash*	\$18.10 - \$18.90 per gallon	Cost savings	Cost savings

* Final Limits effective in 2011 for Specialty Flexography and Screen Printing Press Wash

C. Socioeconomic Impacts

Section 40728.5 of the California Health and Safety Code requires an air district to assess the socioeconomic impacts of the adoption, amendment or repeal of a rule if the rule is

one that “will significantly affect air quality or emissions limitations.” Applied Economic Development of Walnut Creek, California has prepared a socioeconomic analysis of the proposed amendments to Regulation 8, Rule 20. For the purpose of the analysis, it was assumed that flexographic ink used on porous substrates and all cleaning products had an increase in price of 3.5% for both the interim and final cleaning product limits, so as to assess the maximum potential impact on small printing operations. The analysis concludes that the proposed amendments would not have a significant economic impact or cause regional job loss. District staff have reviewed and accepted this analysis. The socioeconomic analysis is attached as appendix 2.

VI Environmental Impacts

A. California Environmental Quality Act

Pursuant to the California Environmental Quality Act, the District has caused an initial assessment study for the proposed amendments to Regulation 8, Rule 20 to be prepared by Environmental Audit, Inc., of Placentia, CA. The assessment concludes that the proposed amendments would not result in adverse environmental impacts. A copy of the study and draft Negative Declaration is provided in the appendix of this staff report. Written comments on the proposed negative declaration are due by October 27, 2008. The CEQA analysis is attached as appendix 3.

B. Greenhouse Gas Emissions

In June 2005, the District’s Board of Directors adopted a resolution recognizing the link between global climate change and localized air pollution impacts. Climate change, or global warming, is the process whereby emissions of anthropogenic pollutants, together with other naturally-occurring gases, absorb infrared radiation in the atmosphere, leading to increases in the overall average global temperature.

While carbon dioxide (CO₂) is the largest contributor to global warming, methane, halogenated carbon compounds, nitrous oxide, and other compounds also contribute to climate change. Gases in the atmosphere can contribute to the greenhouse effect both directly and indirectly. Direct effects occur when the gas itself is a greenhouse gas (GHG). While there is relative agreement on how to account for these direct effects of GHG emissions, accounting for indirect effects is more problematic. Indirect effects occur when chemical transformations of the original compound produce other GHGs, when a gas influences the atmospheric lifetimes of CH₄, and/or when a gas affects atmospheric processes that alter the radiative balance of the earth (e.g., affect cloud formation).

VOCs have some direct global warming effects. However, they are primarily considered greenhouse gases due to their indirect effects. VOC react chemically in the atmosphere to increase concentrations of ozone and may prolong the life of methane. The magnitude of the indirect effect of VOC is poorly quantified and depends on local air quality. Global warming not only exacerbates ozone formation, but ozone formation exacerbates global warming. Consequently, reducing VOC to make progress towards meeting California air quality standards for ozone will help reduce global warming.

District VOC rules typically allow a facility to reduce emissions to the atmosphere through the use of air pollution abatement equipment as an alternative to the use of low-VOC products. The use of abatement equipment versus low-VOC products varies considerably depending on the source category. Such abatement equipment may be thermal or catalytic oxidizers or carbon adsorption. These devices are rarely a cost-effective solution except in the largest facilities. If oxidizers were employed, emissions of CO₂ would be expected to increase due to the use of natural gas to fire an oxidizer. Historically, low-VOC products have been successfully implemented. Increased use of oxidizers to comply with the proposed amendments is very unlikely. Overall, these proposed amendments will not cause emissions of greenhouse gases to measurably increase or decrease.

VII Regulatory Impacts

A. California Health and Safety Code 40727.2 Impacts

Section 40727.2 of the Health and Safety Code requires an air district, in adopting, amending, or repealing an air district regulation, to identify existing federal and district air pollution control requirements for the equipment or source type affected by the proposed change in district rules. The district must then note any differences between these existing requirements and the requirements imposed by the proposed change.

Adoption of amendments to Regulation 8, Rule 20; Regulation 2, Rule 1; and Regulation 3: Fees, would not conflict with any existing federal or District requirement. Under the federal air pollution requirements, one facility, Pechinay Plastic Packaging, Inc. of Newark, CA is classified as a major source and subject to 40 CFR 63, Subpart KK, National Emission Standard for Hazardous Air Pollutants for the Printing and Publishing Industry. The facility's Title V permit requires Pechiney to keep emissions of any hazardous air pollutant (HAP) to less than 10 tons per year, and to keep emissions of all HAP to less than 25 tons per year (40CFR63 KK, §63.820(a)(2)(i) and (ii)) to avoid limitations imposed by the standard, to keep records and calculate emissions (§63.829(d)) and make reports (§63.830(b)(1)). The proposed amendments would not affect or be affected by these permit requirements. The District does not have any other rules that are applicable to graphic arts operations except those of general applicability such as Regulation 8: Organic Compounds, Rule 4: General Solvent and Coating Operations and Regulation 2, Rule 1.

B. Senate Bill 288 Conformity

Senate Bill (SB) 288, later codified in the California Health and Safety Code commencing at §42500, prohibits air districts from making changes to their new source review rules that would make the rule less stringent than it was on December 30, 2002, unless certain conditions are met. The changes to Regulation 2, Rule 1 are not in conflict with the provisions of SB 288. The existing permit requirements allow a graphic arts facility to be exempt if it uses less than 30 gallons of ink and coating per year or emits less than 150 lbs VOC per year from ink and coating usage. The Air District has reviewed permit applications for facilities utilizing lithographic presses that emit less than 20 lbs per year VOC from ink usage yet emit in excess of 2000 lbs VOC emissions per year, the remainder being from solvent clean-up and fountain solutions. These facilities are currently exempt from permits. A collection of such presses with a similar

ink/clean-up profile, as might be typical for a company that specialized in small press runs with short turn-around times, could have 10 presses, still not trigger a permit requirement and emit as much as 20,000 lbs VOC emissions per year. The proposed amendments to Regulation 2, Rule 1 would require graphic arts operations to obtain a permit if they emit 400 lbs VOC per month from ink, coating and all solvent uses combined. This totals 4800 lbs per year, or 2.4 tons. At this level of emissions, compliance with the provisions of the Rule is considered Best Available Control Technology (BACT). Under Air District BACT guidelines, and based on permitting experience, printing sources may have to consider more stringent abatement technology at about 5.5 tons emissions per year. Consequently, sources that could possibly trigger more stringent requirements than compliance with the Rule because of BACT would always be permitted.

VIII Rule Development Process

District staff from the planning, legal, technical, engineering, and compliance and enforcement divisions developed proposed amendments and documented rationale for them in the workshop report. The proposals were based on staff reports and regulations in the South Coast and San Joaquin Valley air districts; email and phone conversations with staff from both air districts as well as the Sacramento Metro and Yolo Solano APCDs; email exchange and telephone discussions with manufacturers and distributors of graphic arts products; phone conversations and meetings with manufacturers of digital printing equipment; email and phone conversations with various graphic arts associations; site visits to various graphic arts facilities in the Bay Area; and technical documents from all of the sources mentioned above. These sources of technical and economic information include Sun Chemical, Day International International, Moquin Press, Pechinay Packaging, Specialty Graphic Imaging Association, Flexographic Technical Association, INX Ink Manufacturing, RadTech, PINC, Valley Ink and Printing Supply, HP INDIGO Press Division, Hewlett-Packard Company, Graphic Science Inks, California Film Extruders Association Ms. Carita Inc., Graphic Arts Technical Foundation, Bradbury & Bradbury, and The Flint Group.

The workshop notice was posted on the District's web site on June 16, 2008, and the notice was mailed to 2,200 Bay Area businesses that are known to undertake graphic arts operations. The first public workshop was conducted at the District offices on July 14, 2008 and the second was held in Oakland in the evening on July 15, 2008 to solicit comments on the draft amendments. Fifteen parties attended the first workshop and ten parties attended the second workshop. Seven parties submitted written comments following the July 2008 workshops. Most parties were contacted to discuss their comments. A meeting was held with one of the parties and a site visit was conducted with another party to better ascertain their concerns. Workshop comments were provided by the following parties:

- Printing Industries of California,
- EPA, Region 9,
- Specialty Graphic Imaging Association,
- Hewlett-Packard (HP) Company,
- Pechinay Plastic Packages,
- RadTech Association for UV and EB Technology; and,
- Bradbury and Bradbury Wallpaper Screen Printing.

Comments pertained to the following issues:

- The proposed implementation date for lower VOC standards,
- Recordkeeping for digital printing equipment and labeling requirements for digital ink,
- A unique wallpaper hand-screening facility; and,
- Availability of 100 gram/liter VOC cleaning products for specialty flexographic package printing and for some screen printing cleaning.

Staff incorporated responses to these comments into the current proposed amendments, as appropriate. After the workshops, staff continued discussions with HP to further identify appropriate categories within the digital printing industry appropriate for recordkeeping requirements. Discussions with HP also related to the applicability of proposed labeling requirements to the digital printing industry.

IX Conclusion

Pursuant to Section 40727 of the California Health and Safety Code, the proposed rule amendments must meet findings of necessity, authority, clarity, consistency, non-duplication, and reference. The proposed Rule amendments are:

- Necessary to protect public health by reducing ozone precursors to meet the commitment of Control Measure SS 2 of the Bay Area 2005 Ozone Strategy;
- Authorized by California Health and Safety Code Sections 40000, 40001, 40702, and 40725 through 40728;
- Clear, in that the amended rule specifically delineates the affected industry, compliance options, and administrative requirements for industry subject to this rule, so that its meaning can be easily understood by the persons directly affected by it;
- Consistent with other California air district rules, and not in conflict with state or federal law;
- Non-duplicative of other statutes, rules, or regulations; and,
- Implementing, interpreting and making specific and the provisions of the California Health and Safety sections 40000 and 40702.

The proposed Rule amendments have met all legal noticing requirements, have been discussed with the regulated community and other interested parties, and reflect the input and comments of many affected and interested parties. District staff recommends adoption of proposed amendments to Regulation 8, Rule 20: Graphic Arts Printing and Coating Operations; proposed amendments to Regulation 2, Rule 1: Permits; proposed amendments to Regulation 3: Fees, Schedule R: Equipment Registration Fees; and adoption of the CEQA negative Declaration.

X References

1. 2005 BAAQMD, Graphic Arts Emissions Inventory,
2. 1998 BAAQMD, Graphic Arts Staff Report,
3. South Coast AQMD, 1999 Graphic Arts Staff Report,
4. South Coast AQMD, Rule 1130 Graphic Arts,
5. South Coast AQMD, Rule 1171 Solvent Cleaning Staff Report, 1999
6. South Coast AQMD, Rule 1130.1 Screen Printing,
7. Joaquin Valley APCD 2007 Draft Staff Report Rule 4607 Graphic Arts,
8. San Joaquin Valley APCD 2007 Draft Graphic Arts Rule 4607,
9. Digital Printing: The Reference Handbook 2004 Uri Levy & Gilles Biscos,
10. Today's Digital Imaging: Version 5.0, 2005, Smart Papers,
11. EPA Office of Compliance sector Notebook Project: Profile of the Printing & Publishing Industry, 1995,
<http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/printpt1.pdf>,
12. Consultation with the Printing Industries of Northern California, March 29, 2007, and August 5, 2008,
13. Multiple consultations with the Specialty Graphic Imaging Association beginning in April 2, 2007,
14. Consultation with Flint Ink July 2006,
15. Consultation with Sun Chemicals April 20, 2007,
16. Consultation with Valley Ink July 28, 2008,
17. Flint Ink Group, August, 22, 2007,
18. American Ultraviolet Company/Aetek UV Systems/Lesco, July 2007,
19. Consultation with Alcan/Pechinay Packaging Company December 19, 2006 and April 17, 2007,
20. Consultation with Moquin Press, January 16, 2007 and May 8, 2007,
21. Consultation with the San Francisco Department of Health Green Business Program August 6, 2008
22. Consultation with Lithotype Packaging Company August 18, 2008,
23. YUPO USA, Technical Resources and Printing Inks Discussion,
<http://www.yupousa.com/content/view/46/116>,
24. Several consultations with Hewlett-Packard during July 2008 and August 2008.
25. Consultation with Bradbury and Bradbury Antique Wallpaper August 5, 2008; and,
26. Consultation with Medtronic CardioVascular September 3, 2008.
27. Morris, M. and Wolf, K. Assessment, Development and Demonstration of Low-VOC Cleaning Systems for South Coast Air Quality Management District Rule 1171, IRTA, August 2003

28. Compatibility Testing of Low VOC Alternative Cleaning Solvents for Lithographic Printing Applications, University of Tennessee Center for Clean Products and Clean Technologies, April 12, 2006
29. Bohan, M. and Lind, J. Assessment, Development and Demonstration of Low VOC Solvents for Cleaning of Lithographic Printing Ink Application Equipment, Printing Industries of America/Graphic Arts Technical Foundation, March 13, 2006
30. Rules 450, 451, 452, 454, 456, 463, 464, 465, 466 Staff Report, Sacramento Metropolitan AQMD, March 28, 2008
31. Consultation with PRISCO Solvent Suppliers September, 8, 2008